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The effects of depression and anxiety on memory performance

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Abstract

The effects of depression and anxiety, as assessed by MMPI *D* and *Pt* scales, on memory performance was examined in 3999 veterans who completed the California Verbal Learning Test (CVLT). Depressive symptoms (without anxiety) had an adverse effect on immediate recall of new information and the total amount (but not rate) of acquisition; however, retrieval and retention were unaffected. On the other hand, high levels of anxiety did not have significant detrimental effects on any aspect of memory functioning assessed including immediate recall, total amount acquired, retention, and retrieval of novel information. However, when depression was compounded by anxiety, there was not only an adverse effect on immediate recall and amount (but not rate) of acquisition, but also on the retrieval of newly learned information. We conclude that the presence of comorbid anxiety may, in part, account for the variability in previous research findings regarding the effects of depression on memory functioning.

Keywords: Depression; Anxiety; Learning; Memory

Recent meta-analytic reviews have suggested a significant relationship between depression and memory impairment (Burt, Zembar, & Niederehe, 1995; Kindermann & Brown, 1997; Veiel, 1997). On average, Burt et al. (1995) found cognitive deficits that were along the lines of one half of a standard deviation. However, there was considerable variability in the

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magnitude of deficits across the moderator variables (e.g., age, depressive subtype, patient status, and stimulus type), suggesting that depression may only be associated with certain aspects of memory functioning and/or that only particular subgroups of depressed individuals may evince such a relationship.

Meta-analytic studies by Kindermann and Brown (1997) and Veiel (1997) attempted to address many of the shortcomings in the Burt et al. (1995) review. For example, Veiel included only those studies that examined depressed individuals without any concomitant neurological damage, while Kindermann and Brown went even further by evaluating the type of comparison group and depression measure used as well as the quality of education matching in the reviewed studies. With the refined inclusion criteria, the resulting support for a significant association between depression and poor memory performance was more reassuring, however, the variability in performance remained. For example, Kindermann and Brown found a bimodal distribution of memory deficits, in their sample of studies, which was attributed mainly to patient characteristics such as depressive subtype and age. It should be noted that a number of individual studies focusing on neurologically unimpaired individuals with major depressive disorder have resulted in equivocal findings regarding the negative effects of depression on memory (Dunbar & Lishman, 1984; Newman & Sweet, 1986; Williams, Iacono, Remick, & Greenwood, 1990). Despite the apparent consistency among meta-analyses, there does appear to be substantial variability within depressed groups. One of the aims of this study is to examine whether and to what extent the variability in memory performance can be accounted for by the severity of depressive symptoms rather than just a categorical diagnosis of depression by DSM-IV or some other diagnostic criteria (e.g., Research Diagnostic Criteria).

Previous review articles and experimental studies have focused on the effects of diagnosed depression on memory functioning (Burt et al., 1995; Kindermann & Brown, 1997; Newman & Sweet, 1986; Veiel, 1997; Williams, Iacono, & Remick, 1990). However, by lumping all depressed individuals into a single group, one is courting greater variability in performance scores due to the general variance in depressive core symptomatology. For example, depressed individuals may or may not exhibit sleep abnormalities, reduced appetite, hopelessness, helplessness, psychomotor retardation, or even depressed mood itself. In addition to the normal variation of cognitive abilities, these interindividual differences tend to enhance the variance of neuropsychological test scores more so than that of normal populations (Veiel, 1997).

Epidemiological studies form 1972 to 1985 have revealed 21% to 91% comorbidity rates between anxiety and depression (Kessler et al., 1996; Zajecka & Ross, 1995). This linkage is suggestive of another way in which depressed individuals may differ and, thus, potentially add to the variability of memory functioning. The empirical evidence for deleterious effects of anxiety, as compared to depression, on memory is less well established. However, a theoretically based review by Eysenck and Calvo (1992) suggests that anxiety hinders memory performance under certain circumstances. For example, anxious individuals have less attentional capacity for task performance and, therefore, perform less well than nonanxious individuals on tasks that make substantial demands on working memory.

Humphreys and Revelle (1984) examined short-term memory (STM) for three- and four-letter problems and their results suggested that anxiety reduces STM capacity. Similarly, a study by Darke (1988) found that the digit-span performance of low test-anxious subjects was approximately 20% higher than that of high test-anxious subjects. However, other studies

have found no significant relationship between anxiety and performance on memory measures. For example, Waldstein, Ryan, Jennings, Muldoon, and Manuck (1997) did not find any relationship between self-reported symptoms of anxiety and performance on memory measures such as verbal learning and story recall. It should be noted that the study by Waldstein et al. only included subjects with subclinical levels of anxiety. As with the low anxiety group in the Darke study, the subclinical levels of anxiety may not have been sufficient to result in significant memory deficiencies.

Considered together, these findings indicate that anxiety, existing comorbidly with depressive symptoms, may be a contributor to the variability in memory performance among depressed individuals who are otherwise cognitively intact. Another aim of the present study was to examine the influence of anxiety with and without depression on memory functioning. Toward this end, the present study examined the relative effects of self-reported symptoms of depression and anxiety, as assessed by the Minnesota Multiphasic Personality Inventory (MMPI; Dahlstrom, Welsh, & Dahlstrom, 1972, 1975) *D* and *Pt* scales, on different aspects of memory functioning as measured by the California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan, & Ober, 1987). Effects of depressive and anxious symptoms were examined, separately and in combination, on acquisition, immediate recall, delayed recall, retention, and memory control (i.e., total intrusions). It was hypothesized that the presence of depression or anxiety, individually, would hinder some aspects of memory performance, but that memory deficits would be most apparent in individuals with coexisting symptoms of depression and anxiety.

1. Method

1.1. Participants

Individual cases ($N = 3999$) were selected, retrospectively, from a larger database of Vietnam era veterans ($N = 4462$) who participated in a mid-1980s study on the effects of the Vietnam experience on veterans (Centers for Disease Control Vietnam Experience Study, 1988a, 1988b). Veterans were evaluated 15–20 years after their Vietnam era military experience. Participants were those individuals from the larger sample who had completed a valid MMPI and a valid CVLT. The overall sample was a random selection of US Army veterans who served during the Vietnam era and who: (1) first entered the service between January 1965 and December 1971, (2) served only one term of enlistment, (3) had at least 16 weeks of active duty, (4) earned a military occupational specialty other than "trainee" or "duty soldier," and (5) had a pay grade no higher than E-5 (sergeant) when discharged. Table 1 outlines the demographic characteristics of this sample. The sample was 82.8% Caucasian, 11.5% African American, and 5.7% other racial designations.

1.2. Procedure

Participants were administered a comprehensive medical, psychological, neuropsychological, and diagnostic interview evaluation described in detail elsewhere (Centers for

Table 1
Demographic characteristics of participants

Variable	Age			Education		GT score[a]		Percent minority
	N	mean	S.D.	mean	S.D.	mean	S.D.	
Entire sample	3999	38.4	2.5	13.3	2.3	106.7	20.0	17.0
Depression								
Low levels	758	38.6	2.6	13.7**	2.3	109.7*	19.5	15.2
High levels	92	38.2	2.6	12.8	2.2	105.3	19.9	21.3
Anxiety								
Low levels	769	38.5	2.6	13.8	2.3	110.3**	19.4	14.8
High levels	47	37.6	1.9	13.1	2.1	100.1	18.5	17.0
Comorbid depression and anxiety								
Low levels	593	38.6**	2.6	13.7**	2.2	110.2**	19.6	14.9
High levels	416	38.2	2.5	12.8	2.2	101.6	20.1	19.0

Racial composition did not differ between any low versus high group comparisons.

[a] GT Score = the General Technical Score administered at time of entry to the military; the GT is a measure of general aptitude.

* Difference between the low and high group significant at $P < .05$.

** Difference between the low and high group significant at $P < .01$.

Disease Control Vietnam Experience Study, 1988a, 1988b). For the purposes of this study, only the results from the MMPI and CVLT were examined. Participants were excluded from the analyses if they had MMPI *T* score elevations above 70 on the *L* or *K* scales, or above 80 on the *F* scale. The CVLT 20-min delayed recognition hits score has also been identified as an index sensitive to valid performance and malingering (Millis, Putnam, Adams, & Ricker, 1995). The frequency distribution of recognition hits was examined. Scores less than 10 were outliers. Therefore, any participant whose CVLT recognition hit score was less than 10 was also eliminated from analysis.

1.3. Data analyses

First, correlation coefficients were calculated between the MMPI *T* scores on the 3 validity as well as 10 standard clinical scales and the 12 CVLT raw scores (Trial 1, Trial 5, learning slope, total words 1–5 [sum of Trials 1 to 5], Tuesday, short delay free recall, short delay cued recall, long delay free recall, long delay cued recall, recognition hits, percent retained from Trial 5 to long delayed free recall, and total intrusions).

Second, a multiple regression analysis with backward elimination was conducted. The CVLT raw score on total words 1–5 was the dependent variable and age, years of education, minority status (coded 1 for white, 2 for minority status), enlistment General Technical score, MMPI *T* scores on *D* and *Pt*, and the interaction between *D* and *Pt* (*T* score of *D* times the *T* score of *Pt*) were the predictor variables. (The General Technical [GT] score was administered at time of entry to the military. The GT score is a measure of general aptitude with a population mean of 100 and a standard deviation of 15.) Total words 1–5 was chosen

Table 2
Mean MMPI *T* score elevations for the six groups

				1	2	3	4	5	6	7	8	9	0
Group	*L*	*F*	*K*	*Hs*	D	Hy	Pd	Mf	*Pa*	Pt	Sc	Ma	Si
Depression													
Low levels	51.1	51.7	55.7	49.7	49.9	53.7	55.5	56.3	52.3	48.5	49.5	57.0	48.9
High levels	51.6	57.5	49.9	56.4	**75.4**	56.2	57.4	58.2	53.7	54.3	54.1	50.6	60.4
Anxiety													
Low levels	50.8	51.8	56.8	50.2	47.9	54.2	56.6	56.8	53.0	50.3	51.1	58.7	47.8
High levels	47.5	58.7	53.4	58.4	54.5	57.3	65.1	60.9	62.8	**74.6**	**71.2**	66.6	55.4
Comorbid depression and anxiety													
Low levels	51.0	51.9	57.0	50.5	50.0	54.5	56.8	56.9	53.1	50.4	51.0	57.5	48.4
High levels	47.9	65.6	47.7	69.2	**85.3**	66.2	**70.7**	63.7	65.9	**81.0**	**78.0**	59.2	66.5

T scores over 70 are in boldface.

as the dependent variable for this analysis because it is the most reliable CVLT index (Delis et al., 1987).

Finally, a series of three MANOVAs were conducted by dividing the sample into groups that scored high versus low on the MMPI *D* and *Pt* scales in the following manner:

1. "High Depression" = *T* score on $D > 70$, *T* score on $Pt < 60$, ($N = 92$), "Low Depression" = *T* score on $D > 45$ and < 55, *T* score on $Pt < 60$, ($N = 758$);
2. "High Anxiety" = *T* score on $Pt > 70$, *T* score on $D < 60$, ($N = 47$), "Low Anxiety" = *T* score on $Pt > 45$ and < 55, *T* score on $D < 60$, ($N = 769$); and
3. "High Depression and Anxiety" = *T* score on *D* and $Pt > 70$, ($N = 416$), "Low Depression and Anxiety" = *T* score on *D* and $Pt > 45$ and < 55, ($N = 593$).

Mean MMPI profile elevations for these six groups are presented in Table 2. To minimize problems of multicolinearity, only eight CVLT variables were used as dependent measures in the MANOVAs. These were the raw scores on Trial 1, learning slope, total words 1–5, Tuesday, long delay free recall, recognition hits, percent retained from Trial 5 to long delay free recall, and intrusions.

2. Results

Results of the correlation analyses are presented in Table 3. Correlations are all low (less than |.15|) although many are statistically significant due to the large sample size ($N = 3999$). Correlations were generally highest between CVLT scores and MMPI *F*, *D*, *Mf*, *Pt*, and *Sc* scales.

Results of a multiple regression analysis with demographic characteristics (age, education, minority status, and enlistment GT score), MMPI scales *D* and *Pt*, and the interaction between *D* and *Pt* as predictor variables of CVLT total words 1–5 raw score revealed that both demographic characteristics and *D* were significant predictors

Table 3
Correlations between CVLT raw scores and MMPI validity and clinical scale *T* scores

				1	2	3	4	5	6	7	8	9	0
	L	*F*	*K*	*Hs*	*D*	*Hy*	*Pd*	*Mf*	*Pa*	*Pt*	*Sc*	*Ma*	*Si*
Trial 1	−.10	−.11	.10	−.09	−.12	−.02	.01	.08	−.04	−.10	−.09	−.01	−.10
Trial 5	−.09	−.10	.09	−.07	−.09	.00	−.01	.11	−.02	−.08	−.09	−.01	−.08
Slope	−.02	−.02	.01	−.02	.00	.00	−.02	.05	.01	−.01	−.02	−.01	−.01
Total words 1–5	−.10	−.13	.12	−.10	−.14	−.01	−.01	.12	−.03	−.11	−.11	−.01	−.12
Tuesday	−.10	−.11	.11	−.11	−.12	−.01	.00	.13	−.01	−.10	−.10	−.01	−.11
Short delay free recall	−.07	−.10	.08	−.07	−.11	.00	−.03	.11	−.02	−.08	−.09	−.01	−.08
Short delay cued recall	−.08	−.10	.08	−.08	−.11	.01	.00	.11	−.01	−.09	−.09	−.01	−.09
Long delay free recall	−.08	−.10	.08	−.08	−.11	.00	−.01	.11	−.02	−.09	−.10	−.02	−.08
Long delay cued recall	−.09	−.10	.08	−.08	−.12	.00	.00	.12	.00	−.09	−.09	−.01	−.09
Recognition hits	−.05	−.03	.04	−.03	−.05	.01	.02	.04	−.02	−.03	−.03	.01	−.07
Percent retained[a]	.01	.01	−.01	.03	.03	.03	.02	.01	−.01	.03	−.03	.00	−.01
Total intrusions	.05	.07	−.06	.04	.04	.01	.02	−.06	.01	.04	.05	.04	.01

Correlations greater than |.03| are significant at the $P < .05$ level, correlations greater than |.04| are significant at the $P < .01$ level, correlations greater than |.05| are significant at the $P < .001$ level.

[a] Percent retained from Trial 5 to long delayed free recall.

Table 4
Group means, standard deviations, and effect sizes on CVLT indices

CVLT variable	High depression [*n* = 92] M (S.D.)	Low depression [*n* = 758] M (S.D.)	Effect size
Trial 1	6.1 (1.7)	6.6 (1.6)	0.31
Learning slope	1.2 (0.53)	1.1 (0.54)	n.a.
Total words 1–5	45.5 (9.3)	47.7 (7.9)	0.28
Tuesday	5.6 (1.9)	5.8 (1.6)	n.a.
Long delay free recall	10.0 (2.8)	10.3 (2.6)	n.a
Recognition hits	14.0 (1.6)	14.0 (1.7)	n.a.
Percent retained	89.8 (19.7)	92.6 (29.7)	n.a.
Total intrusions	1.9 (2.9)	1.5 (2.2)	n.a.

CVLT variable	High depression and anxiety [*n* = 416] M (S.D.)	Low depression and anxiety [*n* = 593] M (S.D.)	Effect size
Trial 1	6.0 (1.8)	6.5 (1.6)	0.31
Learning slope	1.2 (.54)	1.1 (0.54)	n.a.
Total words 1–5	45.1 (9.2)	47.5 (7.9)	0.30
Tuesday	5.3 (1.8)	5.7 (1.7)	0.24
Long delay free recall	9.7 (2.7)	10.2 (2.6)	0.19
Recognition hits	14.0 (1.6)	14.0 (1.6)	n.a.
Percent retained	88.9 (22.6)	92.2 (31.6)	n.a.
Total intrusions	1.5 (2.5)	1.6 (2.3)	n.a.

Mean scores are adjusted for the covariates. Effect size is the difference between the means of the two groups, divided by the standard deviation of the nondepressed or nonanxious group. n.a. = not applicable because ANCOVA was not significant. Percent retained = percent retained from Trial 5 to long delay free recall.

Table 5
Aspects of memory functioning adversely influenced by depression or comorbid depression and anxiety

Group	Novel immediate recall (Trial 1)	Nonnovel immediate recall (Tuesday)	Amount of learning (sum of Trials 1 to 5)	Rate of learning (slope)	Retention (% retained Trial 5 to LDFR)	Retrieval (long delay free recall)	Memory errors (total intrusions)
Depression	Impaired	Intact	Impaired	Intact	Intact	Intact	Intact
Comorbid depression and anxiety	Impaired	Impaired	Impaired	Intact	Intact	Impaired	Intact

[$F(7,3943) = 157.84$, $P < .001$, $R = .401$]. Both *Pt* and the interaction between *D* and *Pt* were excluded in the backward elimination procedure. Examining R^2 and R^2 changes revealed that demographic characteristics accounted for 16% of the variance in CVLT total words 1–5 raw scores, while *D* contributed only an additional 0.7% variance. These results suggest that minimal effects on CVLT performance would be expected from self-reported depression or anxiety symptoms.

Three sets of group comparisons were completed: (1) high versus low depression, (2) high versus low anxiety, and (3) high versus low comorbid depression and anxiety. These groups were first compared on demographic variables — age, level of education, racial composition (white versus minority), and enlistment GT score. High versus low groups in all three sets of analyses were different on level of education and enlistment GT score; the high versus low groups comorbid for depression and anxiety also differed in age. No group comparison was significant for racial composition. Results of these demographic differences are presented in Table 1. Because of these findings, age, education, and enlistment GT score were used as covariates in multivariate analyses (MANCOVA) examining memory performance on various CVLT indices.

High depression versus low depression groups differed significantly on overall CVLT performance [$F(8,838) = 2.11$, $P = .03$] as did groups high versus low on both depression and anxiety [$F(8,997) = 4.78$, $P < .001$]. However, the high anxious group did not differ significantly on overall CVLT performance [$F(8,804) = 1.70$, $P = .09$] as compared to the low anxious group. Group means, standard deviations, and effect sizes for the various CVLT indices are shown in Table 4 comparing: (a) groups high versus low on depression and (b) groups high versus low on both depression and anxiety, while Table 5 presents these data in terms of which aspects of memory functioning appear to be adversely influenced.

3. Discussion

The results revealed that depressive symptoms (without anxiety) have an adverse effect on immediate recall of new information and the amount (not rate) of acquisition, but not on retrieval or retention (long delay free recall and recognition hits, respectively). However, symptoms of anxiety (without depression) did not have a significant deleterious effect on any aspect of memory functioning assessed. This finding, although contrary to our prediction, is not very surprising because previous research (Darke, 1988; Waldstein et al., 1997) has painted a more heterogeneous cognitive portrait of anxious individuals than those who are depressed. In fact, as suggested by the Yerkes–Dodson 'Law', there is a curvilinear relationship between arousal (anxiety) and performance, such that a moderate level of anxiety may actually benefit cognitive performance depending on task difficulty (Eysenck, 1985). In addition, terms such as "moderate level of anxiety" and "task difficulty" have yet to be consistently defined.

What happens to memory performance when depression and anxiety coexist? The results of this study suggest that there is an additional adverse effect on retrieval of new information, along with the immediate recall and amount (but not rate) of acquisition deficits noted in the

solely depressed or anxious groups. In addition, significant group differences on the Tuesday list may indicate that exposure and practice do not attenuate the effects of comorbid anxiety and depression on working memory. The finding that the recognition hit score is comparable between the high and low depressed/anxious groups, while long delay free recall is not, suggests that retrieval is adversely effected while retention is not. These findings may assist in clarifying some of the uncertainties raised by previous research. A number of investigations have indicated that only some depressed individuals have memory dysfunction, but have stopped short of clearly identifying who those individuals are (Burt et al., 1995; Kindermann & Brown, 1997; Massman, Delis, Butters, Dupont, & Gillin, 1992; Veiel, 1997). The current study suggests that among veterans with symptoms of depression and/or anxiety, those experiencing high levels of coexisting depression and anxiety are more likely to have immediate and delayed memory difficulties than individuals reporting either depressive or anxious symptoms alone, or those with low levels of both.

The effect size for depression, and comorbid depression and anxiety, on memory performance is about a third of a standard deviation. When raw scores are converted to *T* scores, for the CVLT sum of Trials 1–5, the difference between the high depression and anxiety versus the low depression and anxiety groups is a *T* score difference of 5.0 (i.e., a half of a standard deviation). These findings denote the clinical, as well as statistical, significance of the present results, and should be taken into account when interpreting scores on the CVLT for individuals reporting depressive and anxious symptomatology.

These data do raise concerns about the long-term functioning of depressed or depressed/anxious individuals. A developing body of literature suggests that older depressed individuals who have had continuing bouts of depression are likely to exhibit increasing cognitive impairment (Basso & Bornstein, 1999; Christensen, Griffiths, Mackinnon, & Jacomb, 1997). In the current study, participants were relatively young, and their deficits were not as severe as those demonstrated by older depressed individuals (Goldstein, McCue, Rogers, & Nussbaum, 1992). Taking a more longitudinal perspective would likely be helpful in answering additional relevant questions that could not be addressed within the framework of the present study. For example, if memory impairment increased over time with chronic depression or comorbid depression/anxiety, this could have significant implications for an individual's adaptive functioning and would be important to address in treatment.

Prior to concluding, several possible limitations of the present study should be acknowledged. In particular, the data are based on a sample of relatively young and healthy veterans. Hence, the present findings may not generalize to older individuals with known neurological impairment. However, one of the weaknesses of previous research has been the presence of confounding dementing illnesses, in an older sample of participants, that may have accounted for much of the variance in memory functioning. Using relatively young participants allows us to more clearly identify the adverse effects of depression and anxiety on memory performance. Furthermore, there was no information regarding the medication status of our sample. As a result, we were unable to control for the effects of psychotropic medication on the cognitive functioning of participants. However, it is unlikely that that medication effects could explain the significant deficits in memory revealed in this study. Despite these shortcomings, the current study provides some evidence for the cognitive heterogeneity of the depression. The implica-

tion being that comorbid anxiety is an important patient characteristic to assess in future research concerning depression and its effects on memory functioning.

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